Folger Sustainable Preservation Environment Project White Paper

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Folger Shakespeare Library
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Folger SHAKESPEARE LIBRARY
Advancing knowledge & the arts

NATIONAL ENDOWMENT FOR THE Humanities

Background

Folger Shakespeare Library is home to the world's largest Shakespeare collection and a primary repository for rare materials from the early modern period (1500–1750), the ultimate resource for exploring Shakespeare and his world. We provide unparalleled access to a huge array of resources, from original sources to modern interpretations, driving discovery and offering opportunities for scholars to pursue ground breaking research. As a major center for scholarship, learning, culture, and the arts located in Washington, DC, the Folger proudly takes its place as an internationally-recognized research library offering advanced scholarly programs in the humanities; an innovator in the preservation of rare materials; a national leader in how Shakespeare is taught in grades K–12; and an award-winning producer of cultural and arts programs—theater, music, poetry, exhibitions, lectures, and family programs.

By promoting understanding of Shakespeare's life and times, the Folger reminds us of the enduring influence of his works, the formative effects of the Renaissance on our own time, and the power of the written and spoken word. The mission of the Folger Shakespeare Library is to preserve and enhance its collections; to render the collections, in appropriate formats, accessible to scholars; and to advance understanding and appreciation of Shakespeare's writings and of the culture of early modern Europe more generally through various programs designed for all students and for the general public. This mission serves a powerful vision of what the Folger can accomplish: to make Shakespeare's early modern world speak powerfully to our own, so that everyone can experience the pleasures and challenges of humanistic inquiry.

The Folger opened in 1932 as a gift to the American people from Henry Clay Folger and Emily Jordan Folger. It is governed by an independent Board of Governors and administered by the Trustees of Amherst College, Henry Folger's alma mater, in accordance with Mr. Folger's bequest. The current annual operating budget is $19.6 million. Last year, visitors to the Folger included approximately 775 readers; nearly 27,900 on-site exhibition attendees and another 308,000 more nationally; and nearly 50,000 attendees to the Folger's theater, music, poetry, and lectures programs. More than 12,000 elementary, middle, and high school students and teachers benefited from the Folger's education programs, which were held at the Folger, in local schools, and at conferences and workshops across the country. Reference inquiries topped 2,000, and the Folger's website, www.folger.edu, logged millions of visitors. The Folger's staff (including Divisions of Collections, Education, Public Programs, Research, and Administrative Services as well as Offices of the Director and Development) includes 128 regular full-time, four grant-funded full-time, and 32 part-time employees.

Preserving our collection is a critical priority of the Folger Shakespeare Library; "to preserve and enhance its collections" is the opening clause of our mission statement. The Folger Shakespeare Library's collections include rare printed books, manuscripts, works of art, audiovisual materials, and modern scholarship. These materials extend beyond Shakespeare to include a wide range of disciplines—e.g. history, politics, theology, exploration, law, and the arts—from the early modern period. New acquisitions of rare and modern materials are made regularly through purchases and the generosity of donors. Collection development policy focuses on building existing strengths in order to enhance the collection's value for in-depth research. It is guided by a team consisting of the Folger's Librarian, Head of Acquisitions, Curator of Rare Books, Curator of Manuscripts, Curator of Art & Special Collections, and Head of Reference. Additionally, the Folger has a dedicated book and paper conservation lab with four conservators and one advanced intern. Conservators collaborate closely with curators to determine how to treat particular items, seeking the delicate balance in each case between treating material and preserving its historic integrity.

Project Overview

Thanks to this implementation grant, the Folger Shakespeare Library (Folger) has completed phase two of the Folger Sustainable Preservation Environment Project (FSPEP). Phase two of FSPEP allowed the Folger to complete needed upgrades to the HVAC systems providing air to most of our collection storage areas. Additionally, it enabled us to continue our work in determining energy saving operations; maximizing the benefit of our storage environments through an appropriate combination of temperature, relative humidity, and dew point conditions. It further allowed us to determine where infrastructure issues played a larger role than anticipated in the conditions in these spaces and our ability to control them. This project was a collaborative effort of Folger Facilities, Conservation, Curatorial, and Reading Room staff guided by the expertise of preservation and energy consultants from the Image Permanence Institute (IPI).

Phase two of FSPEP saw capital improvements to three of the air handlers serving our collection storage spaces: AHU04, AHU14, and AHU15. For a full list of air handlers discussed in this report and the spaces they serve, please see Appendix A. It also saw the ongoing implementation of energy-saving operational changes to five air handlers, monitoring of environmental conditions, and analysis of data collected from six air handlers and four collection storage spaces by the end of the grant. Air handlers AHU01, AHU02, AHU11, AHU14, and AHU15 underwent nightly shutdowns as an energy savings measure when possible. Data from loggers located in the New Reading Room, the Art Vault, the STC Vault, and Deck C as well as in various places within AHU01, AHU04, AHU05, AHU11, AHU14, and AHU15 was analyzed on a monthly basis by Folger Facilities and Conservation staff for the duration of the grant, discussed with IPI staff during three on site visits during the first three years of the grant, and monthly conference calls over the first half of the fourth (extension) year.

In the end, this grant has been a lesson in managing expectations and capitalizing on what is possible. Unforeseen infrastructure problems resulted space conditions that are certainly better than those recorded prior to the grant but optimal conditions could not be sustained year round. Winter conditions on Deck B and Dec C have stabilized within the desired 29°F - 39°F dewpoint range allowing collections to benefit from an RH of at least 35% during the dry winter months. Winter conditions in the New Reading Room have also stabilized above 35% courtesy of the new equipment as well as new operational programming. Summer conditions are still seeing RH levels in excess of the desired 55%. For Deck B and Deck C, this is directly related to the inability of those air handlers to maintain a low enough dew point at the lower temperatures recommended by IPI as part of the NEH Planning Grant previously completed by the Folger and IPI & Herzog/Wheeler. For the New Reading Room, infrastructure issues have resulted in equipment that is not capable of reaching the designed setpoints and therefore does not provide the desired space conditions.

Energy consumption over the course of the grant has proven hopeful despite the mixed results of the capital improvements. AHU01 is exhibiting exactly the desired behavior as shown by a drop in operational costs. AHU05 was rebuilt due to an unanticipated breakdown during the course of this grant. Once operating changes identified during the course of this grant are implemented, it is anticipated that AHU05 will also exhibit the same behavior as AHU01. Although the expenses associated with running AHU04 have increased as a result of this grant, due to its increased role preconditioning air for four downstream air handlers, the energy savings from AHU01 alone more than cover the increased expense of operating AHU04. The Folger expects that the remaining air handlers fed by AHU04 that have not been evaluated by this grant will provide additional energy savings opportunities. Expenses for AHU14 and AHU15 currently exceed pre-capital improvement

levels but as with AHU05, once operational issues identified during the course of this grant are addressed, new equipment installed during construction should result in a significant decrease in operational costs.

Methods and Standards

In 2010, the Folger concluded its NEH Planning Grant looking into ways to maximize the quality of our climate in collections storage areas while simultaneously reducing our energy consumption. Using the metrics established by IPI to evaluate collections risk based on environmental conditions, our primary rare materials storage spaces had an average time weighted preservation index (TWPI) of 62 in 2010. Deck C, where the bulk of our rare materials are stored, was at risk of mechanical damage and four of the six spaces holding rare materials showed risk for metal corrosion. Our New Reading Room, housing many of our valuable paintings and a portion of the modern collection, had a TWPI of 43. In addition to the low TWPI, the planning grant uncovered several air handlers that were dehumidifying year round rather than just during the summer. A third energy savings technique, nightly shutdowns, proved to be effective at lowering energy costs while not impacting the preservation climate to a noticeable degree. The Folger implemented recommendations for programmatic changes that corrected dehumidification activities during the winter months, continued with the nightly shutdowns, and investigated how to execute the capital improvements necessary to correct the low TWPI.

From this beginning, the Folger applied for an NEH implementation grant in 2011. The grant would allow the Folger to:

- pursue the needed capital improvements to three main air handlers serving collections storage spaces
- implement and analyze seasonal setpoints that would allow the Folger to take advantage of outside conditions rather than fight them
- evaluate the effectiveness of the new air handlers through condition data gathered from within the units as well as condition data from the spaces and energy usage data from the fan motors
- drop the temperature in subterranean collections storage spaces to increase the preservation quality of the environment
- practice better dew point control during the summer months to restrict the relative humidity to the desired range.

Completion of the capital improvements and implementation of the seasonal setpoints would theoretically give the Folger significantly improved preservation while still reducing our energy consumption.

Project Activities

2012 – 2015

Beginning October 2012, capital improvements were performed on AHU04, AHU14, and AHU15. AHU04 preconditions air for four air handlers downstream. Capital improvements for this air handler included a new cooling coil capable of generating lower dewpoints, a glycol booster, and a chiller plant. This allowed us to focus all dehumidification operations for collections storage spaces in this one unit, significantly reducing the amount of work the downstream units would need to do. Capital improvements to AHU14 and AHU15 involved changing the order of operations to better suit the outside conditions in Washington, DC and the required interior climate. While changing the

order of operations, new components capable of a delivering a lower dewpoint and increased humidity control were installed.

In April, 2014, Adrienne Bell, Book Conservator, assumed responsibilities as Collections Representative in place of Erin Blake, Curator of Art & Special Collections.

Construction, testing and balancing, commissioning of the rebuilt air handlers as well as the unexpected replacement of the Folger's clean steam boiler were completed by the end of February 2015. The Folger utilizes the clean steam boiler for humidification purposes, making it a vital component in maintaining safe winter conditions within collections storage spaces. Redesign of AHU05 was underway at this time as it had decided to cease operations during the course of construction on the other air handling units.

The first of IPI's onsite visits occurred in April 2015 and saw the installation of dataloggers in AHU01, AHU04, AHU05 (the parts that would remain once the unit was rebuilt), AHU14, and AHU15. Dataloggers were also installed on the variable frequency devices (VFDs) incorporated into the fan motors on AHU04, AHU14, and AHU15. IPI staff, led by Jeremy Linden with support from Christopher Cameron, and Folger staff, represented by David Conine, Head of Facilities, and Adrienne, discussed when to implement the recommended temperature change on Deck C and in the Art and STC Vaults; these conversations would be ongoing for some time before the temperature could feasibly be dropped.

Once the dataloggers were installed, Folger staff routinely downloaded the data. David and Adrienne met monthly to go over the data, compare data from the PEM2s within the AHUs to data being captured by the BMS, and to troubleshoot any problems discovered in house before moving them on to IPI staff. Construction, testing and balancing, and commissioning on AHU05 was completed in October 2015 and the unit was brought back online. Once it was confirmed that the unit was fully operational, we decided to implement the lower temperature in the Art and STC Vaults immediately. Materials usually stored in these vaults had been temporarily relocated due to renovation work leaving these vaults empty. The Folger took advantage of this opportunity to confirm that the system could produce the designed conditions as well as see what type of impact introducing collections materials to a previously empty space would have. We were able to confirm that the equipment could produce the requested conditions and ultimately the introduction of materials to a previously empty space had no impact on the conditions created by the air handler.

2016

IPI returned to the Folger for their second site visit in February, 2016. Additional dataloggers were installed in the new portions of AHU05 and the overall course of the grant to date was discussed. The lack of humidification capabilities for the winter of 2014 – 2015 due to the breakdown of the clean steam boiler meant that data captured from spaces prior to March 2015 would not allow us to assess the performance of the system upgrades and new operational behaviors. With AHU05 offline until October 2015 and the vaults being empty until materials started to move back in December 2015, data from those spaces prior to January 2016 was equally inconclusive. As IPI needed at least three months to perform their analysis of the collected data, we were looking at being unable to provide a full seasonal year of clean data for analysis prior to the grant ending in December, 2016. Also, although the temperature in the Art and STC Vaults had been lowered as recommended, the temperature on Deck C had yet to be lowered leaving us without a seasonal year of data for all three spaces at the lower temperature. The Folger and IPI decided it was necessary to request a one year, no cost extension to the grant so that these data gaps could be filled in.

Additional outcomes of this visit were to adjust mechanical dampers in the physical spaces to adjust the amount of air flow from the ducts to the rooms; change the nightly shutdowns from 8 hours to 6 in certain spaces to offset the drift being seen in the data; consider installing dampers in between AHU04 and all downstream units as the ongoing movement of air from AHU04 to the downstream units despite the shutdowns on those units was the likely cause for the nightly shifts being seen; and adjust the programming for the heating coils as they were currently producing more heat than was necessary for the spaces. All these outcomes were addressed except for the dampers which would require capital improvements and is still pending.

For the remainder of the year, Folger staff continued to download data from the air handlers. The monthly meeting also continued the habit of discussing conditions in all collections spaces, identifying problems and potential malfunctions inside and outside of the scope of the grant, and determining ways of improving existing conditions. The ongoing communication and exchange allowed David and Adrienne to continue evolving as a partnership dedicated to providing the best conditions for collections. The requested one-year extension to the grant was approved in September, 2016.

2017

IPI returned to the Folger for their third and final site visit in January, 2017. Kelly Krish joined Jeremy Linden and Christopher Cameron for this visit. IPI and the Folger brought several concerns to the table regarding data trends, air handler operations, and setpoints. One primary concern was that the Folger still had not lowered the temperature on Deck C. Although it would now not be possible to gather a full seasonal year of data at the lower temperature, the decision was made to push forward with the Folger making the change as soon as possible to gather as much data as we could.

AHU04 was another primary concern. Data showed that air leaving AHU04 was gaining 10°F of heat and 7°F of dewpoint by the time it arrived in the downstream air handlers. This was creating a situation where AHU05 was not able to produce the designed setpoints during the summer because the moisture load coming into the equipment was already too high. AHU14 and AHU15 were also not delivering the desired summer setpoints put forth by IPI due to dewpoint issues. For these air handlers the problem was compounded by changes in the setpoints during the design phase. The initial dewpoint put forth by IPI was determined to be impossible to meet by the engineering company and the new equipment was thus designed for a higher set point. The equipment was not even managing this higher dewpoint however due to issues with chilled water flow that had not been anticipated or accounted for in the design process. The dewpoint recommended by IPI for these units was 45°F, the design dewpoint was 50°F, and the delivered dewpoint was 57°F. These changes all led to a higher relative humidity in the summer months than desired.

IPI suggested several steps during their visit to address the problems AHU04 was having. Folger staff implemented all recommendations from IPI during the course of their visit. This reduced the heat gain in AHU04 by 5°F but did not measurably reduce the dewpoint gain. IPI recommended having an engineer conduct a survey of AHU04 to continue efforts to reduce heat and dewpoint gain. Additionally, a datalogger was installed in AHU11, which had previously been unmonitored, to confirm all the downstream units from AHU04 were receiving higher moisture air. AHU14 and AHU15 would require additional capital investment before the necessary dewpoints could be produced. As the Folger was preparing to move forward with plans for a major building renovation tentatively scheduled to begin in 2020, David informed IPI that no further capital investments

would be made in AHU14 and AHU15 and that we would only be monitoring those units moving forward. Conditions would be controlled to the best of the equipment's abilities through programming changes but otherwise would remain unchanged. IPI and the Folger decided to continue meeting via conference calls for the next several months as the grant moved towards completion.

The temperature on Deck C was dropped in February, 2017. Although the setpoint in the BMS was 55°F, the temperature in the space never dropped below 58°F. While it may have been possible to drop the temperature further by reducing the setpoint in the BMS, nothing was done to address this issue because by the time we confirmed the temperature would not drop further, the season had changed and the dewpoint had risen outside the desired range. The higher delivery dewpoint of the air coming from AHU04 meant that the RH in Deck C was considerably higher than desired during the summer months. The temperature in the Art and STC Vaults was raised from 55°F to 58°F hoping to combat the high RH as much as possible but both these spaces were consistently above the desired dewpoint from mid-May to the beginning of October, 2017.

The engineering study performed on AHU04 in July, 2017, revealed more areas that needed to be resealed or further insulated. This was completed and the dataloggers showed a 3°F reduction in the heat and dewpoint gain, bringing both down to 2°F. As the dataloggers have a margin of error of +/- 2°F, AHU04 was considered to be as fully modified as possible. Unfortunately, residual shifts in temperature and dewpoint remain between AH04 and downstream units. The Folger and IPI have concluded that this problem must now be related to the ductwork connecting the units. As such, it will be addressed as part of the Folger's 2020 renovation plans.

David Conine, Head of Facilities, left the Folger in July 2017 and was replaced by Dustin Humbert in October, 2017.

Ongoing Activities/IPI Recommendations

IPI has recommended that the Folger continue its investigation into the moisture gain from AHU04 to AHU01, AHU02, AHU05, and AHU11. Until such time as that problem has been solved, a safer summer temperature of 60°F - 64°F should be used. Additionally, IPI discovered that AHU05 is currently undergoing extensive subcool/reheat activities during the winter months. As this unit was rebuilt during the grant, the current analysis is the first operational analysis performed on the unit. The Folger will work to correct the subcool-reheat operations for the future. Final analysis of the data from AHU14 and AHU15 revealed that in additional to the dewpoint issues previously discussed, the two units are fighting each other. As they provide conditioned air to the same space, it is possible for them to provide two different extremes in conditions which blend to create the desired climate. This is exactly what is happening with AHU14 delivering cool air to the space and AHU15 delivering extremely warm air. This is a very energy intensive process that also adds to the moisture load issues. The Folger will work to correct this issue. AHU14 and AHU15 both also are experiencing issues with their economizer setting and the Folger will work with our controls contractor to resolve this issue over the next 12 months.

As part of our preparations for the proposed 2020 building renovations, the Folger is undergoing an evaluation of all the mechanical systems within the building. This evaluation is part of the process for developing a Mechanical Engineering Plumbing Fire (MEPF) Master Plan. The issues brought to light by this grant and the recommendations made by IPI will be incorporated into the MEPF Master Plan and addressed over the next 4 years.

Energy Analysis

Despite the overall mixed results of the capital improvements, an energy analysis performed for 2017 shows that the Folger will experience significant energy gains once several key areas are addressed. AHU01 is currently operating as anticipated, performing only sensible cooling and heating on the air being delivered from AHU04. Once the subcooling/reheating operation on AHU05 is corrected, it too should only be performing sensible cooling and heating. Shifting the summer setpoints will influence this to a certain extent but should not be a significant change. Although the costs associated with running AHU04 are now greater than they were prior to the capital improvements, the reduced costs of running AHU01 already more than cover the increased costs of AHU04. Once AHU05 is operating correctly, the overall savings will increase. Although the two remaining air handlers downstream of AHU04, AHU02 and AHU11, were not studied in this grant, we anticipate that we they are also offering the same opportunity for energy savings as we fine tune operations further. Modifications in how AHU14 and AHU15 are currently operating will also increase energy savings. Required changes to the programming to address the fighting will reduce the energy consumption of each unit, hopefully in such a way that more energy savings are seen.

Outcomes

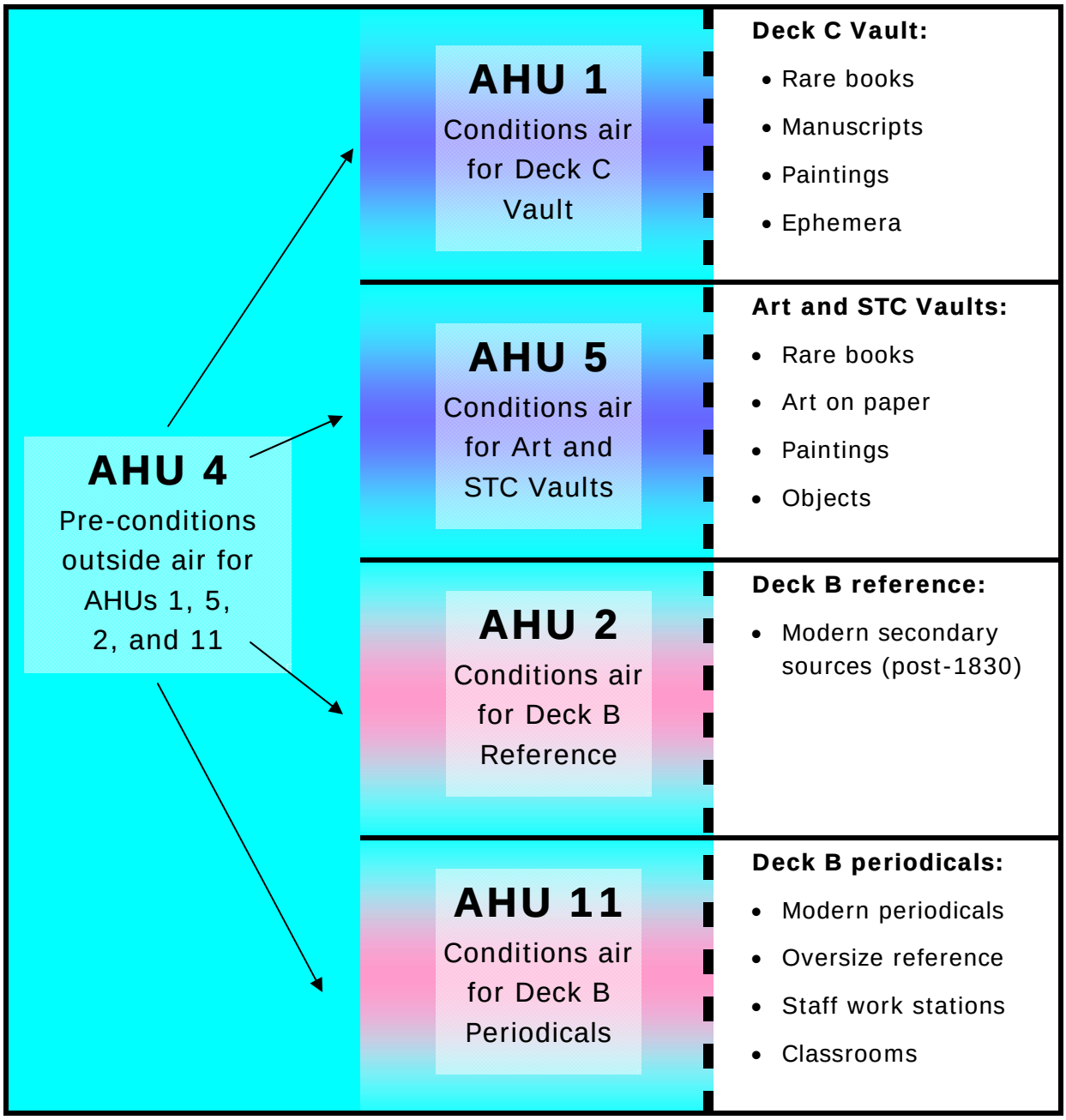
The grant produced a mixture of positive outcomes and new challenges. The word "negatives" has deliberately been avoided because these issues can and will be resolved in the long-term; the opportunity to discover them through this grant is as vitally important to the future of the Folger collections as the intended outcomes had been. With a few modifications to existing setpoints, the preservation climates involved in this grant will all see some degree of improvement. Whether substantial or not, improvement remains improvement. The preservation climates in Folger collection storage spaces during the winter months have already been significantly improved. Slight changes to the summer setpoints will result in the improvement of those same climates during the summer months. Operational changes that may take a little more time to implement will see improvements in energy consumption while retaining the same level of improvement in the collections spaces. The Folger, with the assistance of IPI and NEH, has accomplished the improvement of conditions in our collection storage spaces while still reducing our energy usage and will continue to do so while reducing our energy consumption ever further. This is truly something to be celebrated.

An important outcome of this grant has been a change in the overall institutional approach to how climate conditions are established and maintained throughout the Folger. The knowledge obtained by Folger staff through the course of this grant has been instrumental in shaping not only this grant but how the Folger is approaching the upcoming 2020 renovation plans. The Folger established a pattern of behavior and expectations through the course of this grant that developed a very close working relationship between Collections and Facilities. The conversation around climate conditions originally were restricted just to air handlers that serve collection storage spaces but has since evolved into a conversation about how the environment within our heritage building influences how it ages as well as how the presence of collections in spaces that are predominantly staff or user spaces requires managing in much the same way as the storage spaces.

Upon the departure of David Conine, collections concerns were a very strong component of the search for a new Head of Facilities. Collections personnel were involved in the search process and had a voice in evaluating candidates. As the new Head of Facilities, Dustin came on board aware of the necessity of involving Collections in decisions about collections spaces, storage or otherwise,

and that the building itself needed to be treated as part of the collection. Dustin has been instrumental in involving Adrienne and the Folger's Head of Conservation, Renate Mesmer, in decisions about how the air handler systems will be designed in the 2020 renovations. Dustin and Adrienne are working together to identify a new network of sensors to incorporate into the BMS allowing for better tracking and analysis of data from within the air handlers as well as within the physical building spaces. With his background in risk management and safety, Dustin has moved the Folger into new territory by contracting a Mechanical Engineering Plumbing Fire (MEPF) Master Plan that will allow the Folger to plan for the life expectancy of its air handler systems. As systems near the end of their life expectancy, plans for their replacement will be designed for dew point control in the summer in addition to humidification in the winter, to undergo nightly shutdowns or vary fan speed based on space needs, and incorporate sensors allowing for real time data collection and long-term trending. All of this will be done with Folger collections staff heavily involved in the discussion and all of this can be directly related back to what the Folger has learned through the course of the two recent NEH grants allowing us to plan for and implement more sustainable preservation environments.

Appendix A: Air handler units



AHU 14

East end of New Reading Room

AHU 15

Service Vault and West end of New Reading Room

New Reading Room:

- Paintings
- Reference books
- Researcher work stations
- Staff work stations

Service Vault: short-term storage of rare books, manuscripts, art on paper

The following air handler units also serve the Folger Shakespeare Library, but were not part of this grant project

201 East Capitol Street

AHU 3: Deck A vault

AHU 6: Paster Reading Room ("Old Reading Room")

AHU 7: Exhibition Hall

AHU 8: West wing offices

RTU 9: Conservation lab

AHU 10: West wing basement

AHU 12: Basement offices

AHU 17: Box office, upper and lower theater lobbies

AHU 18: Theater (West side)

AHU 19: Theater (East side)

301 East Capitol Street

AHU 1: Basement

AHU 2: 1st floor conference room

AHU 3: 1st floor offices & hallway

RTU 4: 2nd floor

RTU 5: 3rd floor north offices

RTU 6: 3rd floor southwest offices